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Experience is defined in terms of the interaction between two models, an "environment" model and a "primitive learner" model. The latter is so constructed to be a legitimate element of the former and so as to have some interesting implications for human and animal performance which it purports to simulate.

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A Definition of Experience Based on a Primitive Learning Model

Introduction

The term "experience" has a broad range of definitions. It is used not only to refer to the specific events through which a person passes but to the accumulated recollections of these events, to the length of time devoted to a specific subset of these specific events, to mention only some of the possible meanings. Thus, we find that the term encompasses many of the central problems in epistemology.

To avoid confusion we will use a somewhat restricted definition for experience in this paper. The *Shorter Oxford Dictionary* defines experience as "the observation of facts or events, considered as a source of knowledge." It will be noted that this definition contains three elements: an "observer", an "environment" composed of "facts or events", and the "interaction" between these two primary elements to produce the secondary element "knowledge."

In order to elaborate this definition into a functional statement of epistemological problems, it is necessary to generate two models: (1) an "environment" model and (2) a "primitive leaner" model, which must, of course, be one of the elements of the "environment" model. If these two models are allowed to interact, the result represents "knowledge." We can then consider the whole process to be a functional definition of experience.

The "Environment" Model

The constituents of an *environment* are not always directly quantifiable and, since they are not necessarily ordered, neither a matrix nor a lattice is exactly appropriate for our definition. In our effort to define an *environment,* we will, therefore, generate a lattice-like structure which we will call a "state of affairs" and then show that, by combining these "states of affairs" in certain ways, an *environment* can be generated.

Fundamental Constituents

Analagous to the mathematical concept of point, we will assume a particular quality which we will call an *attribute (a, b, . . .).* This attribute will be considered such that it is drawn from a universe set of attributes. Attributes have the following characteristics:

1. *Distinguishability* ($\hat{d}$)*—each attribute may be in some way distinguishable from at least some other members of the universe set from which it is drawn.
2. *Equivalence* ($\equiv$)—each attribute may be in some way indistinguishable from at least some other members of the universe set from which it is drawn.
3. *Comparability* ($\hat{c}$)—in order to be able to distinguish one attribute from another some form of comparison between attributes must be made.

Thus, for the ith and the jth attribute the following relationships hold.

$$(a_i \ \hat{d} \ a_j) \ \mathrm{v} \ (a_i \equiv a_j) \text{ but not } (a_i \ \hat{d} \ a_j) \ . \ (a_i \equiv a_j)^{**}$$

i.e., attributes may or may not be distinguishable from each other but two attributes are not both distinguishable and indistinguishable from each other.

This relationship implies a number of others, for instance:

If $a_i \ \hat{c} \ a_j \equiv a_i \ \hat{c} \ a_k$
then $a_j \equiv a_k$
etc.

4. Scalability ($\hat{s}$) —at least some attributes are scalable in the sense that if the comparisons between pairs of unlike attributes are in some way equivalent, then all the attributes with this property are members of the same scale.

If $a_i \ \hat{d} \ a_j \ \hat{d} \ a_k \ \hat{d} \ a_l$

but $a_i \ \hat{c} \ a_j \equiv a_k \ \hat{c} \ a_l$

then there is a scale S_m such that

$$S_m \subset a_{mi}, \ a_{mj}, \ a_{mk}, \ a_{ml}$$

*The symbols used in this paper for characteristics or operations are included in parentheses following the name of the operation.

**The following symbols from logic are used throughout this paper:
(.)—and, (v)—or, and ($\subset$)—the inclusion set

Fundamental Components

A component (C) is a set of attributes. It has one important characteristic not present in the attributes themselves. The characteristic is:

1. *Uniqueness* (U)—a component is a component if and only if the set of attributes which constitutes the component is at least in some way different from all other constituent sets. These differences may be slight or large, involving one attribute or more.

   i.e., $(C_{a_1, \ldots, a_m}) \ \hat{d} \ (C_{a_1, \ldots, a_n})$ where $m \neq n$

or $(C_{a_1, \ldots, a_n}) \ \hat{d} \ (C_{b_1, \ldots, b_n})$ where a and b are attributes.

A State of Affairs

A "state of affairs" is a set of components. Hence, the universe of all states of affairs is the set of all possible components.

There are several possible kinds of components. We will confine ourselves for the purpose of this discussion to three, namely the object components, the event components, and the condition components.

1. *Object components* (α)—an object component is part of the subset of the universe state of affairs which is *physically identifiable* at any given time t_0. The universe of object components is the object state of affairs (A).
2. *Event components* (β)—an event component is a component which is identifiable as representing some possible transformation of an object component over a time interval t_2—t_1. The universe is (B).

   Replacement ($\leftarrow$)—the transformation which occurs to form an event component is of one kind only. Some subset of the attributes of an object component is replaced by a new subset such that the uniqueness principle continues to apply. This replacement may not occur in some cases, i.e., the null transformation.

i.e., $\beta_c \equiv C_{a_i} \leftarrow C_{b_j}$

where i may or may not equal j

except for the null transformation.

It should be noted that the maintenance of the uniqueness principle makes the event state of affairs also a subset of the universe of components. A further restriction occurs because of the uniqueness of each object which excludes from each object some of the possible events; hence, the set of all possible events which could occur to a particular object over any particular time interval t_2—t_1 is a subset of the universe of event states of affairs.

3. *Condition components* (γ)—it will be assumed that a replacement event will occur if and only if a particular set of conditions relative

to the particular attribute of the particular object component are met. The condition universe is (Γ).

It should be noted that although these three states of affairs each are composed of components, each state of affairs is unique from the others. That is, there are no components C_α, C_β or C_γ such that:

$$(C_{\alpha_i} \equiv C_{\beta_j}) \vee (C_{\alpha_i} \equiv C_{\gamma_k}) \vee \ldots$$

Environment (E)

An environment will be defined as a lattice-like structure composed of *elements.* The elements of any environment have the following characteristic:

An Element (*e*)—is the intersection of two or more components each of which must be drawn from a different state of affairs.

Figure One illustrates this relationship.

VENN DIAGRAM ILLUSTRATING THE GENERATION OF AN *ELEMENT*

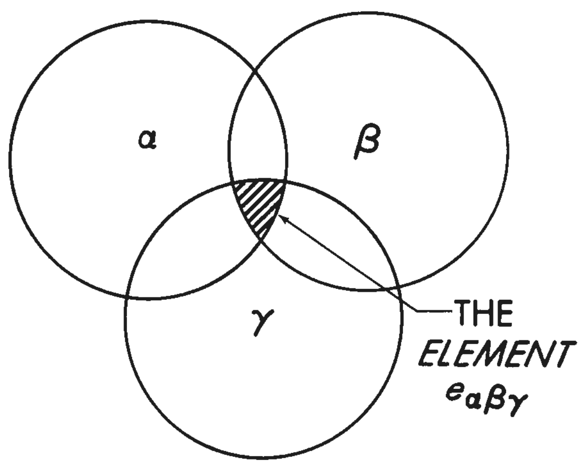

FIGURE 1

Thus the Environment $E_{\alpha\beta}$ represents the total possible environment in infinite time, whereas the Environment $E_{\alpha\beta\gamma}$ represents any possible finite environment over any finite time.

Since the definition of the various components is constant, changes in the environment $E_{\alpha\beta\gamma}$ are equivalent to corresponding changes in the attribute constituents of the elements $e_1, \ldots, e_n$ such that:

$$E_{\alpha\beta\gamma} \subset \{e_1, \ldots, e_n\}$$

Any total observable environment is equivalent to the intersection of its constituent object, event and condition states of affairs.

$$E \equiv AB\Gamma$$

It should also be noted that of the three states of affairs only A is physically identifiable at any time t_0, hence, although B and Γ are present, their presence and nature can only be inferred by observing transformations of A over the time t_2—t_1.

Causation (→)

One of the characteristics of the conditional state of affairs is that changes which can occur in an element are of two classes, *Output,* in which some change in the attribute constituents of element e_i occur as a result of undefined internal changes in e_i, and *Input,* in which changes in e_i are at least partially attributable to changes in at least one other element.

1. *Simple Causation*
   Simple causation would then be definable as output from one element leading directly to input in another. Thus:
   $\Delta e_i \rightarrow \Delta e_j$ where Δ means "change."
2. *Process*
   Multiple causation or *process* can be defined as:
   $\Delta \{e_i \ldots e_m\} \rightarrow \Delta \{e_j \ldots e_n\}$
3. *Feedback and chains*
   This idea of multiple causation and multiple effect suggests several other possibilities. For instance, in certain circumstances, input into a set of elements may change the conditional relations within this set in such a way as to bring about output from this second set. The new output can go in either or both of two directions, toward the original output, in which case we have *feedback,* or toward a third set of elements, in which case we have a *chain* reaction.
4. *Cycling, growth and decay processes*
   There are other possibilities which should be considered. Combinations of feedback and chaining can lead to *cycles.* This effect can be produced either by feedback or by a closed chain.

   Growth and *decay* processes are inverses of each other. If the output of an element or group of elements is such that, relative to the conditions in force, the resulting changes lead to an *increase* in the volume of output, this is a growth process. The converse is a decay process.

5. *Equilibrium states*
   If the growth and decay processes balance each other or if a stable cycle is established, an *equilibrium* state occurs. If growth or decay within or outside of a cycle are very slow, then a *quasi* equilibrium state results. It is necessary therefore to distinguish between short and long run equilibria.

Summary

We have defined an *environment* as a unique set of unique elements. Those *elements* are, in their turn, the intersection of at least two *components*, each drawn from a distinct *state of affairs*. Components are made up of unique sets of *attributes*. In order for *states of affairs* to be distinct when drawn from the universe of components, sets of restrictions involving the nature of the attributes contained in the components are established.

Finally *attributes* are defined as distinguishable members of an undefined universe. This definition reduces the system to the point and point set basis characteristic of a mathematical system. Attributes have a number of properties other than distinguishability, most notably *equivalence* and *scalability*.

The fact that conditional statements can be part of environmental elements makes the application of N value logic possible in this system. Also a number of possible *processes* are suggested. It is not, however, our intention to explore exhaustively at this time the mathematical properties of an environment as defined. The model has been developed for a specific applied purpose, that of defining experience. Its properties are sufficiently like those of our natural physical environment for our present purpose.

The Primitive Learner

As already stated our primitive learner must be an element in the environment. We will need to select from this environment an element capable of both input and output, and of all three processes—cyclic, growth and decay.

In order for this element to be capable of all three of these processes, it must be capable of internal modification of input and the initiation and direction of output, as well as being a self-sustaining system. It is to the possible characteristics of such an element that we now turn our attention. It is this element which we will designate as a *primitive learner.*

All self-sustaining systems have these three characteristics and their related subfunctions:

A. *Input:*
   1. selection
   2. decoding

B. *Information analyzing**
   1. recognition
   2. orientation
   3. recall
   4. specification of error tolerance
   5. analyzing strategies
   6. arousal
   7. data capacity

C. *Output:*
   1. selection
   2. encoding
   3. feedback

We will discuss each of these in turn and specify a model of a primitive learner which meets these requirements.

A. *Input:*

Since the elements of the environment are composed of distinguishable attributes, there is a need for some sort of input mechanism which has the capability of recognizing these differences.

Mechanical and electromagnetic transmissions from elements either by reflection or in the form of direct output are the most easily distinguishable by possible mechanical, electrical, or electro-chemical sensing devices. Even when confined to this sort of attribute, the possible amount of information is very large. It is usual for sensing devices to be further restricted to particular critical transmission types. Sensing devices select from the possible range of input particular critical forms of input, critical in the sense that they are critical to the function of the system. This characteristic of *selection* has two important functions; first, it removes a considerable amount of redundancy from the input and second, it reduces the amount of input which the system is required to analyze.

Self-sustaining systems have the problem of functioning within the restrictions of *real time*, hence data reduction is of primary importance.

This selection process operates in two dimensions, (1) the *nature* of the input to which the sensor is selective and (2) the *range* of sensitivity. Range refers to the two input qualities of frequency and intensity.

In addition, input arrives at the sensors in a number of different modes. Since it is unlikely that the system can analyze all of these modes, it becomes necessary to translate or *decode* at least some of these modes into a form more suitable for analysis within the system. This decoding involves, in effect, the translation of all input modes into a single system-

*We are using the term *analysis* in the place of the more usual term *process* in conjunction with the term information in order to avoid confusion with our earlier use of the term *process*.

amenable code. In this latter case there is no need for there to be any similarity between the systematic code and the sensory input mode it designates so long as the equivalence is recognizable by the system. It is from this latter fact, as we shall see in more detail later, that a symbol system can be derived.

B. *Information Analyzing*

1. *Percepts:* As has already been indicated, it is necessary for the system to recognize the sensory input in order to be able to analyze it. In self-sustaining systems this recognition is accomplished in several different ways. To begin with, certain types of input are usually *flagged,* that is, they carry a distinctive marking in order to identify their nature. These flags are analagous to the positive or negative signs used in mathematics to signal directed numbers. These flags are built into the code. A second way of flagging a signal is to include in it an override signal which is looked for by the analyzing strategies. In computer terminology, these signals usually lead to a branching point in the programme.

A third way to flag a signal is to compare it with information already stored in memory. In order to do this, there must be access to some form of memory in order to store information, either temporarily or permanently, and some way of calling for this stored information so that the comparison can be effected.

The first method of flagging an input signal in our primitive learner will be called *recognition*; the second will be regarded as *orientation.* The override characteristic of the "orientation reflex" will be discussed later with reference to the development of goals. Finally, the comparison with memory will be called *recall.* It is usual for perception theorists to combine these three systematic characteristics into one process, the process of *percept* formation.

2. *Concepts:* We have a second process in the analysis of information, that of *concept* formation. We shall treat this topic under four headings.

The first is the *specification of error tolerance.* There are two aspects of this tolerance, one which is innate, the other which is learned. Since the input process involves a substantial reduction in data quantity, it also introduces some error. If this error is critical, some form of compensatory strategies must be developed. On the other hand, the restrictions imposed on the system by functioning within the confines of real time make extensive elaboration unrealistic if not impossible. In short, the system must know when to desist. Hence the error tolerance in any given situation must be specified, either by external criteria as part of input, or by internal criteria as part of some goal definition. The override function of orientation provides for the external definition. In such cases, however, the criteria established on the basis of internal goals may remain unsatisfied. We will discuss later the possibility that conflict between input and analysis demands on the system may be an important aspect of learning. Another importance of error tolerance will be discussed later.

If information is to be analyzed, there must be some *method of analysis.* Piaget* suggests that there are sixteen categorical relationships and four closed transformations of these sixteen at the basis of the formal logic ability of adults. This particular aspect of our primitive learner will be developed in more detail in a subsequent paper. At present it is sufficient to say that this *groupement* as he calls it has most of the characteristics of a mathematical group, particularly, the operations of converse, reciprocal, negation and identity. In order to develop these operations and the related categorical relationships, there must be a necessary and sufficient minimum set of primitive strategies from which all of the others can be derived.

Although the full mathematical properties of the minimum set put forward here have not been explored it will be suggested that three strategies form this necessary and sufficient set. These three strategies will be designated as (1) inclusion, (2) exclusion and (3) coupling.

1. *Inclusion* (ε)—this strategy in its primitive form will be essentially perceptual, involving the flagging of information as similar to or identical to previously stored information.
2. *Exclusion* ($\tilde{\varepsilon}$)—this strategy is the inverse of inclusion.
3. *Coupling* ($\int$)—this strategy in its primitive form ties together two or more primitive strategies into a generated strategy.

It should be noted that inclusion (ε) and the formation of the inclusion set ($\subset$) in logic are not identical operations. By the inclusion operation we mean that two elements are considered equivalent if a reasonable subset (by reasonable we mean within the specified limits of error tolerance) of the attribute constituents of one element are equivalent to a corresponding subset of the other.

In order to indicate the difference between inclusion (ε) and set membership ($\subset$) we need a new operation. This operation is the *Definition* (*Df*) strategy and refers specifically to the chain of primitive operations which form the strategy. Hence, for a set p, defined by the inclusion (ε), two or more elements make up this set if any subset of the attributes of these elements is equivalent for all the elements in question. Symbolically: If $\{a_i, \ldots a_m \mid e_k\} \equiv \{a_j, \ldots a_n \mid e_l\} \equiv \ldots$

Then $p\ Df\ \varepsilon$ for the elements $e_k, e_l, \ldots$

*The specific calculus for this *groupement* as he calls it are found in his *Logic and Psychology,* New York, Basic Books, 1958.

It must be recognized that such categorical representations must, of necessity, be spurious. In fact, $e_k \hat{d} e_l$ since by definition the total set of attributes of e_k and of e_l are not equivalent because of the uniqueness restriction.

Furthermore in order to establish a logical class, it is necessary to establish class limits. That is, the non-examples of the same class must also be defined. Hence, to define any particular class p we must couple an inclusion to an exclusion. Thus: $p\ Df\ \varepsilon \int \tilde{\varepsilon}$

These strategies should be regarded as analagous to a computer program through which any appropriate information can flow to give conformable though not equivalent results.

We can readily see that these three strategies considered in this manner, forming into various kinds of processes, can be expected, not only to generate categories, but also because of the presence of a positive, an inverse and a uniting strategy, may be able to generate all the possible categorical relationships and the possible transformations on these relationships.

If a set of primitive strategies such as this are present in the actual psychological functioning of the human infant, their very presence and nature would explain the lawful sequence which characterizes Piaget's *genetic epistemology* since higher order strategies would have to be generated before certain types of analyses become possible.

The third of our topics in this section is *arousal.* If a self-sustaining system has only one analysis channel, then input and output velocities effectively determine the analysis velocity. System overloads occur only at input and output points. However, our primitive learner, although selective, is sensitive to multimodal input. In this case if the number of input and output channels exceeds the number of analysis channels, with each addition of an input or an output channel, the possibility of a system overload at points within the system other than at input and output points expands exponentially. This problem is further complicated by variable input and output demands and the restrictions of operating within real time. Of course the system can overcome some of the problem by modifying the specifications for error tolerance. To optimize analysis capacity however, there must also be some mechanism to modify the analysis procedure to meet the varying demands of input and output. This mechanism we will call *arousal.* It will be assumed to consist of a limited set of deployment and diversionary strategies which are innate, plus a whole set of learned strategies which set priorities and modify error tolerance specifications.

Finally in spite of the efficacy of arousal to optimize the data analysis of the system, it is still necessary to postulate the possibility of data overload in any finite system. This possibility implies an absolute maximum of data volume for efficient analysis. Beyond this point analysis would be expected, under the influence of the data pile-up which would occur by the over-application of the arousal strategies, to become progressively less efficient. The inverted "U" shape of the arousal curve found in humans may well be analogous to the process just described. In fact, it may be possible to generalize this model even further by suggesting that the essential difference between the learning capacity of various organisms may be some relationship between the number of input and output channels usable, the number of analysis channels available and the degree to which data can be effectively simplified before it is analyzed or after analysis in calling for output. We will call this optimal system level the system's *data capacity.**

C. *Output:* Having once analyzed the data some form of output may be called for. This process involves the *selection* of appropriate output, the *encoding* of the output into some form of action signals which can be translated meaningfully by some form of output mechanism and some type of feedback to ensure that output has been satisfactorily executed.

This feedback also provides information to input which can, in a self-sustaining system, lead to continuance, modifications, termination, or override signals to the output mechanism. Override signals are particularly important in such diverse activities as social contacts and the sport of karate.

Summary

We have devised, in this section, an element of the environment which can receive input, generate output and so modify its behaviour through feedback with the aid of innate and generated strategies that it can produce, within the limits of its data capacity, any or all of the processes characteristic of the environment. In so doing, again within its data capacity and its functional life expectancy, it may be regarded as a self-sustaining system. To be self-sustaining means that it must be able to modify its behaviour to meet the needs of internal and external changes. In other words, it must be able to learn. Since we claim that we have proposed a model with the minimum essential requirements to meet the demands of real time imposed by our environment model, we argue that we have generated in this section a *primitive learner.* This model is primitive in the sense that a simpler model would not be self-sustaining in the hypothetical environment proposed. Diagrammatically the model looks like this:

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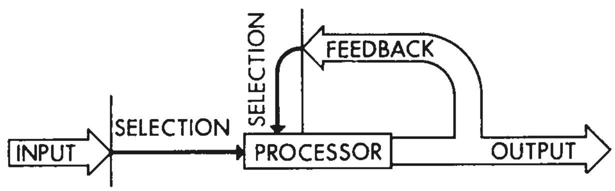
*Miller suggests that this capacity in humans is "Seven plus or minus two."[1]

THE *PRIMITIVE LEARNER* AS A *PROCESSOR*



Learner—Environment Interaction

As we have already seen, our primitive learner selects a subset of the data available for analysis purposes. Since these subsets can be equivalent even when the sets from which they are drawn are unique, the generation of classifications becomes possible. Storing these simplified classifications in memory makes them available for recall. It is from this process of classification and storage that a symbol system emerges.

Of what, we may ask does this symbol system consist? Taking into account the interaction of orientation, arousal, data capacity and error tolerance specifications, we can imagine a system with little or no memory having a very limited selection zone. As objects from the environment become organized into simple inclusion and exclusion classes, certain kinds of transformations of these classes which are related to immediate need-goals will be identified. These will become linked with growing output facility to produce rather complex object—event—action complexes which once in memory serve to flag current input.

It is assumed that some of the most primitive output needs are established as innate reflexes and these reflexes will be assumed to be a substitute for learning. Thus we would expect that the higher the innate data capacity the more primitive and the fewer the reflexes.

Our original symbols then are object—event—action symbols which we will call *eidetic** symbols (because of their connection with eidetic imagery) and will suggest that they are idiosyncratic to each unique system. Furthermore these symbols will be experience and perception bound.

The linking of object and event with action (output) can easily be equated with the primitive development of goals. It is probable that as goal oriented behaviour becomes more highly organized the orientation reflex becomes less important. It is also probable that the function of this reflex changes, leading eventually to such phenomena as the "circular reactions" which Piaget contends are the origins of intelligence.

*Bruner subdivides this symbol system into two representational systems, namely *enactive* and *iconic*.[2]

At a later stage, if the system has the capacity for this level of sophistication, formal (conventional) symbols can be substituted for eidetic symbols.

It should be noted that at any time t_0 only objects are contained in input and events and conditions must be inferred from object transformations over short or long time intervals. Hence, objects become the major content of the first symbol systems. Event and condition symbols except in so far as these are related to immediate need-goals will have to await the mastering of output before they can be explored.

Thus, we would expect a gradual differentiation of symbol systems from the global eidetic (e') to particular eidetic (α', β', γ') to global formal (e'') and so on. As the learner develops the ability to separate object, event and condition states of affairs from the elements in his environment, his ability to predict outcomes improves. The increase in classification ability and its concomitant improvement in prediction leads directly to a simplification of the data being analyzed. As the data are simplified, the effect is a functional increase in the data capacity, which means that the input volume can be increased by broadening the focus zone and by increasing the precision possible in the specification of error tolerance.

Piaget[3] divides this adaptive process into two subprocesses, assimilation and accommodation, which he describes symbolically as follows: (using our symbolism)

ASSIMILATION

$a_1 \int e_1' \rightarrow \tilde{a}_2$

$a_2 \int e_2' \rightarrow a_3$

$a_3 \int e_3' \rightarrow a_1 \ldots$ where $a_1, a_2, \ldots$ are internal states

We will notice that a percept of an element (or an element set) from the environment is coupled with some internal strategy leading to some form of cycle. This can but need not involve output. The learner uses his present repertoire of strategies and categories to restore the equilibrium state.

ACCOMMODATION

$a_1 \int \tilde{e}_1' \rightarrow \tilde{a}_2$

$\tilde{a}_2 \int e_2' \rightarrow a_3$

$a_3 \int e_3' \rightarrow a_1 \ldots$

In this case a "new" percept ($a_1 \int \tilde{e}_1'$) is identified by the learner. This occurrence generates a new strategy or classification ($\tilde{a}_2$), which, if successful, restores the cycle to equilibrium; again output is possible but unnecessary. In both cases the restoration of equilibrium is the reinforcing agent to learning.

Of course, this whole process is greatly facilitated by the introduction of formal symbols. As this process progresses, the learner's ability to cope with the ultimate uniqueness of each element in his environment steadily increases. At all stages, of course, there is an element of error in his deliberations, but this error is steadily reduced.

Outlook and Summary

We have proposed a model for an environment and a model for a primitive learner, which latter is an element in the former. We have then allowed these models to interact so that we can now define *experience* as "the interaction between the learner and his environment."

Exactly what this definition means in terms of these models with respect to developmental sequence, error types at various stages, rates of learning, and comparisons of potential learning by varying the specifications of such parameters as arousal level, data capacity and error tolrance await a full scale simulation of the model complex. Also the similarities between this model complex and actual human and animal learning await the testing of hypotheses which can be generated from the model.

A few of these hypotheses follow:

A. Individuals with equal data capacity and equal arousal level will learn equal amounts in the same time interval. However, the quality of the learning may differ with the present strategy and category level of the individual; hence a low-performing student in school may learn as much as a high-performing student. The difference between their performances may lie in the fact that the low performer's strategies and categories are inadequate and/or inappropriate to the tasks set, which means that what he learns is confusion.

B. There will be qualitative as well as quantitative differences between the kinds of learning at different levels of development and among different species. This difference will depend on:

1. The set of innate reflexes
2. The data capacity of the individual
3. The stage of the individual's development.

These qualitative differences will be most evident in the characteristic kinds of error made.

C. Humans are capable of any level of abstraction at any level of development, provided:

1. The problem can be translated into the category and strategy systems currently operative in that individual.
2. That the discriminations required can be made sufficiently gross that they exceed the current error tolerance specification.

3. That the problem be decomposed into steps sufficiently small that the data analysis required does not exceed the data capacity of the individual.
4. That the solution of the problem can be related in some way to the current need-goal structure of the individual.

This last hypothesis spells out the conditions for learning which can be derived from the model. The implications of this last hypothesis for such technologies as programmed instruction are obvious. There are also corollaries to each of these which state that the reduction of the problem need not go any further than these four specifications; going further introduces redundancy.

Further exploration and refinement of this model complex is in progress. An immediate follow-up analyzing Piaget's system in more detail against the complex is being undertaken. The implications of this model to the physiological and biochemical function of the nervous system could be explored. Also the relationship between this model and the work of theorists other than Piaget could be fruitful. Finally, there is the possibility of the exploration and generalization of the mathematical aspects of this model complex which could prove very interesting as well. In any case, we feel that these ideas are worthy of further development.

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